UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2009/2010 Academic Session

April/May 2010

IEK 105 – TREATMENT AND MANAGEMENT OF SOLID WASTE
[PENGOLAHAN DAN PENGURUSAN SISA PEPEJAL]

Duration: 3 hours
Masa: [3 jam]

Please check that this examination paper consists of ELEVEN pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer FIVE (5) questions. Answer **ALL** questions in **PART A** and **ONE** question in **PART B**. You may answer the questions either in Bahasa Malaysia or in English.

[Arahan: *Jawab LIMA (5) soalan. Jawab* ***SEMUA*** *soalan dalam* ***BAHAGIAN A*** *dan* ***SATU*** *soalan dalam* ***BAHAGIAN B****. Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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PART A (ANSWER ALL QUESTIONS)

1. Given the solid waste components and characteristics in Table 1.

   (a) Estimate the as-discarded density of the solid wastes?

   (7 marks)

   (b) If the compaction ratio, r is 2.5, what is the size of collection vehicle is needed per 1000 kg wastes?

Table 1 Solid wastes components and characteristics

Component	Weight, kg	Density, kg/m^3
Food waste	25	200
Paper	35	90
Cardboard	10	50
Plastic	10	60
Yard waste	20	100

(7 marks)

(c) You are as the contractor of a solid waste collection firm had signed an agreement with a community consists of 15 apartment complexes. The discarded volume of solid waste to be collected is 100m^3 per collection day.

(i) Determine the number of trip required on collection day.
(ii) The size of vehicle and
(iii) The size of containers to be provided.

(6 marks)

Given information:

Vehicle compaction ratio, r = 2.5
Driving time between container location, dbc = 0.1h
Time to clear one location, p = 0.2h
Time spent to unload the cargo of solid wastes at the destination point, s = 0.1h
Working hour per day = 8 h
Wasted time fraction, W = 0.15
Driving time from dispatch station, t_1 = 20 min
Driving time to dispatch station, t_2 = 25 min
Round trip distance = 60 km
Speed = 30 km/h
$d_l = dbc\ (C_l-1)/C_l$ $N_t = [(1-W)\ H-t_1-t_2]/t_{net}$ $t_{net} = (p+d_l)C_l+s+h$

2. Explain briefly **FIVE** phases of stabilization processes of solid waste in the landfill

   (a) Phase 1 Initial adjustment
   (b) Phase 2 Transition
   (c) Phase 3 Acid formation
   (d) Phase 4 Methane fermentation
   (e) Phase 5 Maturation

(20 marks)

3. (a) (i) Estimate the percolation of water through a landfill of 10 m deep, with 1-m cover of soil and

(7 marks)

(ii) Determine how long does it take to produce leachate?

Assume that this landfill has

Precipitation rate, P = 1525 mm/year
Runoff coefficient, R = 0.15
Evapotranspiration rate, E = 660 mm/year
Storage capacity, S = 150 mm/year
Moisture content of incoming wastes = 150 mm/m
C = P (1-R)-S-E

(7 marks)

(b) Estimate the required landfill area for a community with a population of 50,000.

Assume that the following conditions apply:

Solid waste generation = 3.8 kg/(capita.d)
Compacted specific weight of solid wastes in landfill = 400 kg/m^3
Average depth of compacted solid waste = 4 m

(6 marks)

4. (a) Give **FOUR** examples of hazardous waste compounds that may be found in municipal solid waste (MSW).

(4 marks)

(b) List **THREE** laws of Malaysia under Environmental Quality Act, 1974 related to scheduled waste.

(6 marks)

(c) List **THREE** potential sources of hazardous waste generated in a university environment. Indicate what properties make such substances hazardous.

(10 marks)

PART B (ANSWER ONE QUESTION ONLY)

5. The composition of solid wastes is given in Table 2 below.

Table 2 Solid wastes component and characteristics

Component	Weight, kg	Moisture content, %	Percent by weight (dry basis)					
			C	H	O	N	S	Ash
Food waste	25	70	48.0	6.4	37.6	2.6	0.4	5.0
Paper	35	6	43.5	6.0	44.0	0.3	0.2	6.0
Cardboard	10	5	44.0	5.9	44.6	0.3	0.2	5.0
Plastic	10	1	60.0	7.2	22.8	-	-	10.0
Yard waste	20	65	47.8	6.0	38.0	3.4	0.3	0.3

(a) Estimate the overall moisture content of the solid wastes.

(8 marks)

(b) Determine the chemical composition of the solid wastes described in Table 1

(i) with sulfur (with and without water)
(ii) without sulfur (with and without water)

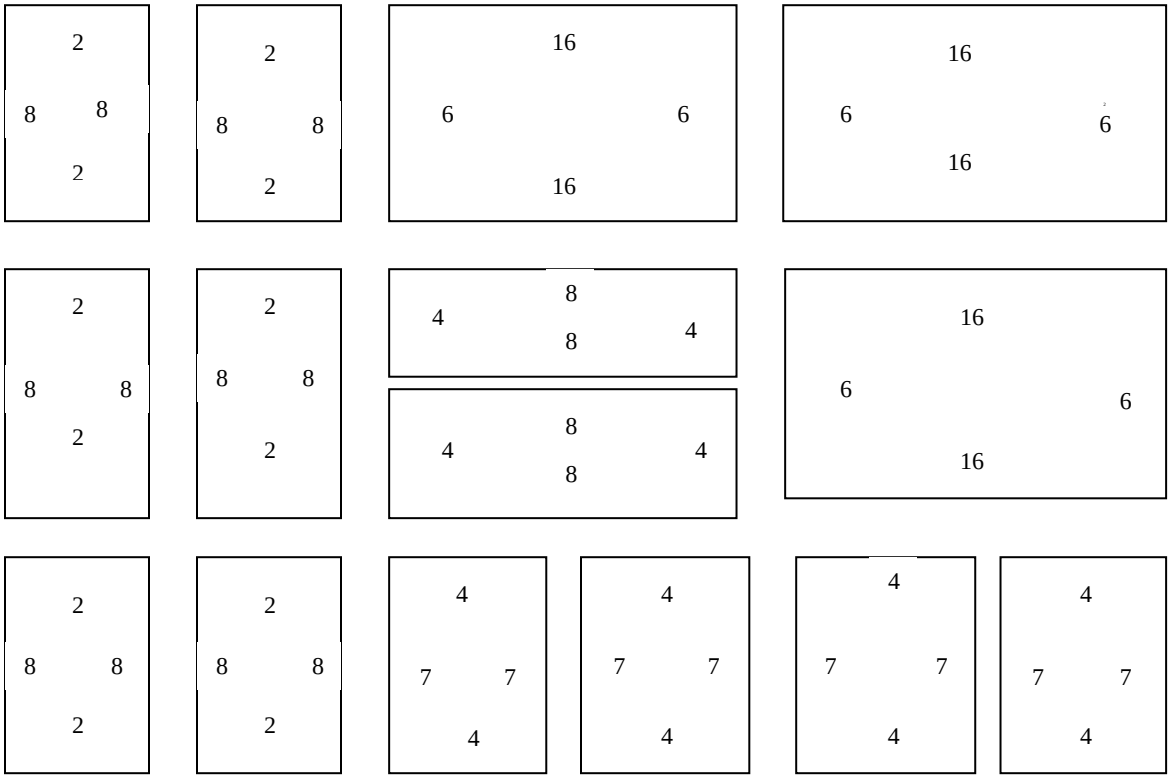
(12 marks)

6. (a) Sketch out a collection routes for the residential area shown in Figure 6.

Assume that the following data are applicable:

Occupants per residence	=	3.1
Solid waste generation rate	=	3.75 kg/capita.day
Collection frequency	=	once per week
Type of collection service	=	curb
Collection crew size	=	1 person
Collection vehicle capacity	=	26 m^3
Compacted specific weight of solid waste in collection vehicle	=	590 kg/m^3

Figure 6 Map of residential areas for municipal solid waste collection services



2, 4,6, 7, 8, 16 = number of residences along each block

(17 marks)

(b) Name **THREE** group of microorganisms that are working in the composting process.

(3 marks)

7. (a) List down all the important parameters in the composting process.

(3 marks)

(b) Write a short note on

(i) composting
(ii) fermentation
(iii) biogas

(9 marks)

(c) Describe briefly the following clinical waste categories. Give **TWO** examples of each waste category.

(i) Pathological waste
(ii) Genotoxic waste
(iii) Infectious waste

(8 marks)

BAHAGIAN A (JAWAB SEMUA SOALAN)

1. *Diberi komponen dan ciri-ciri sisa pepejal seperti di dalam Jadual 1.*

   (a) Anggarkan ketumpatan semasa pembuangan sisa pepejal tersebut ?

   (7 markah)

   (b) Jika nisbah padatan, r ialah 2.5, apakah saiz kenderaan pengangkut yang diperlukan bagi 1000 kg sisa pepejal tersebut ?

Jadual 1 Komponen sisa pepejal dan ciri-cirinya

Komponen	*Berat, kg*	*Ketumpatan, kg/m^3*
Sisa makanan	*25*	*200*
Kertas	*35*	*90*
Kadboard	*10*	*50*
Plastik	*10*	*60*
Sisa laman	*20*	*100*

(7 markah)

(c) Anda sebagai kontraktor yang bertanggungjawab bagi sebuah firma yang memungut sisa pepejal telah menandatangi satu perjanjian dengan komuniti yang mengandungi 15 kompleks apartment. Isipadu sisa pepejal yang perlu dipungut ialah 100m^3 dalam hari pungutan. Anda dikehendaki menentukan.

(6 markah)

(i) Jumlah trip yang diperlukan dalam hari pungutan yang ditentukan.
(ii) Isipadu kenderaan pemungut dan
(iii) Saiz kontena yang diperlukan.

Maklumat yang diberikan adalah seperti berikut:

Nisbah mampatan kenderaan pemungut, r = 2.5
Masa memandu antara lokasi kontena, dbc = 0.1 jam
Masa 'membersihkan' satu lokasi, p = 0.2 jam
Masa untuk memunggahkan kargo sisa pepejal di stesyen pemindahan,s = 0.1 jam
Masa bekerja sehari = 8 jam
Pecahan masa terbazir, W = 0.15
Masa memandu dari garaj, t_1 = 20 min
Masa memandu ke garaj, t_2 = 25 min
Jarak pusingan trip = 60 km
Kelajuan = 30 km/jam
$d_l = dbc\ (C_l-1)/C_l$ *$N_t = [(1-W)\ H-t_1-t_2]/t_{net}$* *$t_{net} = (p+d_l)C_l+s+h$*

2. *Terangkan secara ringkas **LIMA** fasa di dalam proses penstabilan sisa pepejal yang berlaku di tapak pelupusan.*

   (a) Fasa 1 Penyesuaian
   (b) Fasa 2 Peralihan
   (c) Fasa 3 Pembentukan asid
   (d) Fasa 4 Fermentasi metana
   (e) Fasa 5 Maturasi

   (20 markah)

3. *(a) (i) Anggarkan kadar perkolasi air yang berlaku di dalam sebuah tapak pelupusan yang berkedalaman 10 meter yang ditutupi dengan tanah 1 m tebal dan*

   (7 markah)

   (ii) Anggarkan masa yang diperlukan untuk leachate terhasil.

   Anggapkan tapak pelupusan tersebut mempunyai

   Kadar prepitasi, P = 1525 mm/tahun
   Koefisien air larian, R = 0.15
   Kadar evapotranspirasi, E = 660 mm/tahun
   Kapasiti muatan, S = 150 mm/tahun
   Kandungan lembapan sisa pepejal = 150 mm/m
   C = P (1-R)-S-E

   (7 markah)

   (b) Anggarkan luas tapak pelupusan sisa pepejal yang diperlukan bagi komuniti yang mengandungi 50, 000 orang penduduk.

   Maklumat yang diberikan:

   Kadar penjanaan sisa pepejal = 3.8 kg/(kapita.hari)
   Berat spesifik termampat sisa pepejal dalam tapak pelupusan = 400 kg/m^3
   Kedalaman purata sisa pepejal termampat = 4 m

   (6 markah)

4. *(a) Berikan **EMPAT** contoh sebatian sisa berbahaya yang boleh diperolehi dalam sisa pepejal perbandaran (MSW).*

   (4 markah)

*(b) Senaraikan **TIGA** undang-undang Malaysia dibawah Akta Kualiti Alam Sekeliling, 1974 yang berkaitan dengan sisa terjadual.*

(6 markah)

*(c) Senaraikan **TIGA** sumber sisa berbahaya yang berpotensi dijana dalam persekitaran universiti. Nyatakankan juga ciri-ciri yang membuat sisa yang disenaraikan tersebut berbahaya.*

(10 markah)

BAHAGIAN B (JAWAB SATU SOALAN SAHAJA)

5. Komposisi dan ciri-ciri bagi sisa pepejal seperti yang ditunjukkan di dalam Jadual 5.

Jadual 5 Komposisi sisa pepejal dan ciri-cirinya

Komponen	*Berat, kg*	*Kandungan lembapan, %*	*Peratusan berat kering*					
			C	*H*	*O*	*N*	*S*	*Abu*
Sisa makanan	*25*	*70*	*48.0*	*6.4*	*37.6*	*2.6*	*0.4*	*5.0*
Kertas	*35*	*6*	*43.5*	*6.0*	*44.0*	*0.3*	*0.2*	*6.0*
Kadboard	*10*	*5*	*44.0*	*5.9*	*44.6*	*0.3*	*0.2*	*5.0*
Plastik	*10*	*1*	*60.0*	*7.2*	*22.8*	-	-	*10.0*
Sisa laman	*20*	*65*	*47.8*	*6.0*	*38.0*	*3.4*	*0.3*	*0.3*

(a) Anggarkan kandungan lembapan bagi keseluruhan sisa pepejal tersebut.

(8 markah)

(b) Tentukan komposisi kimia (formula kimia) bagi sisa pepejal yang diberikan di dalam Jadual 5.

(i) Dengan sulfur (mengandungi air dan tanpa air)
(ii) Tanpa sulfur (mengandungi air dan tanpa air)

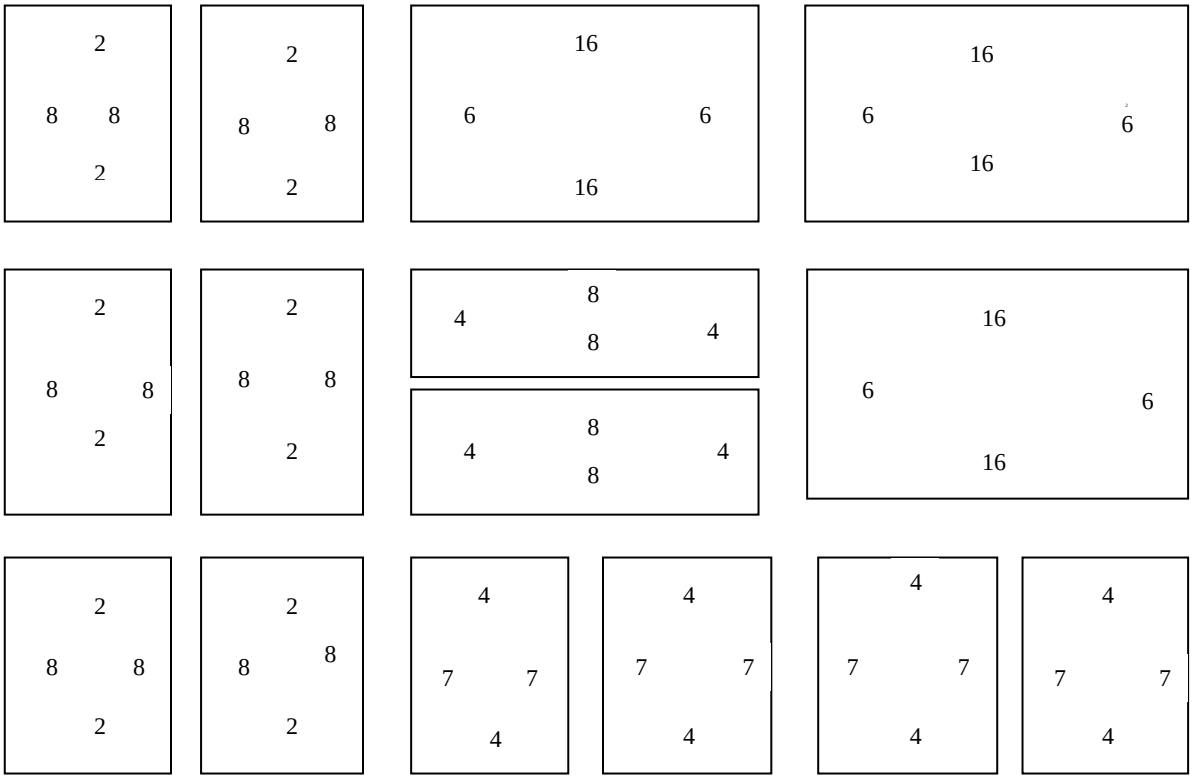
(12 markah)

6. (a) *Lakarkan laluan pengutipan bagi kawasan perumahan yang dipamerkan dalam Rajah 6.*

Gunakan data-data berikut sebagai anggapan anda:

Penghuni per kediaman	=	*3.1*
Kadar penjanaan sisa pepejal	=	*3.75 kg/kapita.hari*
Kekerapan pengutipan	=	*sekali dalam seminggu*
Jenis servis pengutipan	=	*susur jalan*
Saiz krew pengutipan	=	*seorang*
Kapasiti kenderaan pengutip	=	*26 m^3*
Berat spesifik sisa pepejal termampat dalam kenderaan pengutip	=	*590 kg/m^3*

Rajah 6 Peta kawasan perumahan untuk servis pengutipan sisa pepejal perbandaran



2, 4, 5, 6, 7, 8, 11, 10, 16 = bilangan kediaman sepanjang setiap blok

(17 markah)

(b) *Namakan **TIGA** kumpulan mikroorganisma yang berperanan dalam proses pengkomposan.*

(3 markah)

7. (a) *Senaraikan kesemua parameter utama dalam proses pengkomposan.*

(3 markah)

(b) *Tuliskan catatan ringkas berkenaan*

(i) pengkomposan
(ii) fermentasi
(iii) biogas

(9 markah)

(c) *Secara ringkas terangkan setiap kategori sisa klinikal berikut. Berikan **DUA** contoh bagi setiap satu kategori sisa tersebut.*

(i) Sisa patologi
(ii) Sisa genotoksik
(iii) Sisa berjangkit

(8 markah)